Combined Effects of Fire-Retardant Treatments and Extended Exposure to Elevated Temperature

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Fire retardant (FR) treated wood has been used for nearly 50 years in the United States. FR treatments reduce wood strength and these reductions must be considered in the design process. However, additional strength reductions related to thermal degradation have recently been encountered with the use of some FR treatments for plywood roof sheathing and roof trusses. The Forest Products Laboratory has mounted a large research program into this phenomenon. As a result a number of reports have been recently published on: problems with FR-treated plywood used as roof sheathing (LeVan and Collet 1989), the thermo-chemical factors involved (LeVan and Winandy, 1990), time-temperature effects on strength (LeVan et al 1990), design guidelines (Winandy 1990), review of the development and an evaluation of the new ASTM Emergency FRT-Plywood Standard (Winandy et al 1991), and the effects of cyclic thermal exposures (LeVan and Kim 1991).

It appears that FR treatments can be classified by the type of FR employed and the time-temperature combination required to convert the FR formulation into its acidic form (LeVan et a1 1990). While permanent thermal degradation occurs for both FR-treated and untreated materials exposed at 180 F, FR generally accelerate the initiation of wood strength loss. However, after thermal-induced degrade has initiated, the rate of strength degradation over time of exposure appears similar between treated and untreated materials, even though there are large differences in strength (LeVan et al 1990, Winandy et al 1991). It also appears that as RH increases, the rate of strength degradation increases (Winandy et al 1991). However, the effect of RH does not appear to be as influential as the effect of the temperature of exposure.

While steady-state exposure to elevated temperature is theoretically quite severe, from a practical standpoint the results of steady-state testing appears less severe than field experience. This observation is based on the fact that the level of degradation in mechanical properties and wood composition induced by steady-state laboratory exposures of 170°F/79% RH and 180°F/50% RH is far less than the magnitude of the degradation often experienced in the field. Thus, another significant variable may be involved in field failures, such as a lack of post-treatment kiln-drying, excessive redrying kiln temperatures, or very acidic FR chemicals.

Based on this research and the unacceptable performance of some commercial FR treatments, FR treated lumber and plywood should not be considered an interchangeable commodity item. Architects and engineers must be aware of the fact that not ail FR-treated wood is equal. New test methods are available to differentiate between various proprietary commercial FR treatments. Compliance with design guidelines will help a structure perform as expected (Winandy 1990). FPL is now expanding this research program to predict the effects of post-treatment kiln-drying and combined high temperature-high moisture environments. We also want to develop predictive roof temperature models and field-to-laboratory correlations which will lead to a roof-sheathing serviceability model.

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